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Evaluation of a lifetime-based optode to measure oxygen in aquatic systems

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Web Appendix 1

Salinity compensation of oxygen readings from optode and calculation of % saturation at a given salinity and temperature (Garcia and Gordon, 1992).

Input variables:

$[O_2]$ = O_2 concentration in µM, from the optode

t = temperature in degrees Celsius, from the optode temperature sensor

S = salinity in ppt, from a parallel salinity measurement

Empirical constants:

$A_0 = 2.00856$

$A_1 = 3.22400$

$A_2 = 3.99063$

$A_3 = 4.80299$

$A_4 = 9.78188 \times 10^{-1}$

$A_5 = 1.71069$

$B_0 = -6.24097 \times 10^{-3}$

$B_1 = -6.93498 \times 10^{-3}$

$B_2 = -6.90358 \times 10^{-3}$

$B_3 = -4.29155 \times 10^{-3}$

$C_0 = -3.11680 \times 10^{-7}$

Intermediate calculations:

T_s = scaled temperature = $\ln[(298.15 - t)/(273.15 + t)]$

$\alpha = S(B_0 + B_1 \cdot T_s + B_2 \cdot T_s^2 + B_3 \cdot T_s^3) + C_0 S^2$

$\beta = A_0 + A_1 T_s + A_2 T_s^2 + A_3 T_s^3 + A_4 T_s^4 + A_5 T_s^5$

Final results:

Salinity compensated oxygen concentration

O_2 [µM] = $[O_2] * e^{\alpha}$

100% oxygen saturation with air at a pressure of 1013 mbar:

$O_{2,100\%\ sat}$ [µM] = $e^{(\alpha + \beta)} / 2.2414$

percent saturation in the given water

$O_{2,sat}$ [%] = O_2[µM] / $O_{2,100\%\ sat}$ [µM]